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(71) Applicant: **ASAHI MACHINERY LIMITED**
Takaishi-shi, Osaka 592 (JP)

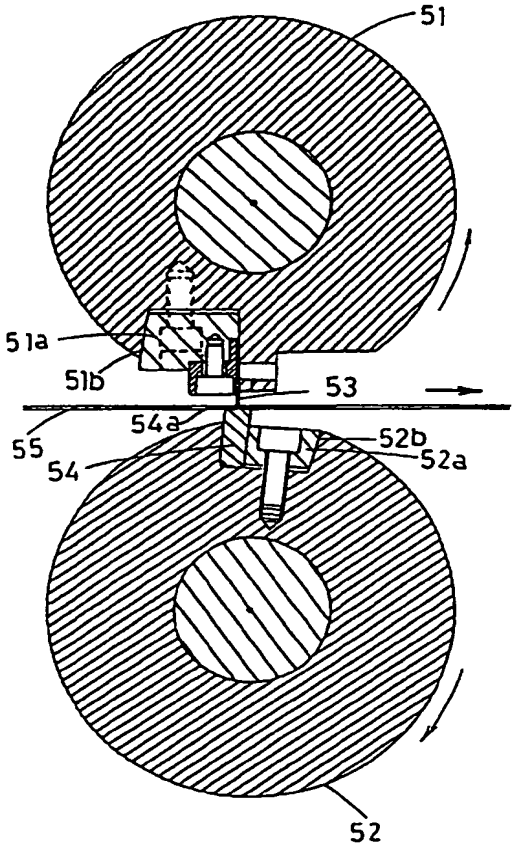
(72) Inventor: **Okahashi, Yoshiharu**
Takaishi-shi, Osaka 592 (JP)

(74) Representative: **Hillier, Peter et al**
Reginald W. Barker & Co.,
Chancery House,
53-64, Chancery Lane
London, WC2A 1QU (GB)

(54) Rotary cutter

(57) A knife holder 51a is secured to a spirally formed groove 51b of a knife rotor (thus far being called a top-rotor) with screws. A commercially available lengthy dual thin-edged knife 53 is secured to the knife holder 51a. A pressing member 52a is secured to a spirally formed groove 52b of a plane rotor (thus far being called a top-rotor) with screws in conjunction with a circumferential surface member 54. The knife rotor 51 and the plane rotor 52 are conjunctionally rotated to cut off a roller paper 55 by cooperating the dual-edged knife 53 and the circumferenctial-surface member 54 secured thereto.

Fig.12



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Description

BACKGROUND OF THE INVENTION

The present invention relates to a rotary cutter for continuously cutting off a paper or a cardboard by a predetermined length.

In order to continuously cut off a paper or a cardboard, conventionally, various rotary cutters have been used. Especially, a full synchro rotary cutter (called "synchro-fry cutter" hereinafter) has a superior mechanism in which a knife is equipped in a groove spirally provided in a longitudinal direction of external surface of a top rotor and a bottom rotor whose rotate shafts are in parallel each other. In operation, the top rotor and the bottom rotor are rotated synchronizedly according to the feeding speed of paper so that a lengthy paper is cut off by intercrossly cutting off the paper as though operating a pair of scissors.

In order to cut off a paper with the synchro-fry cutter, two knife rotors must correctly be synchronized. To achieve this, neither the positional error nor the positional unstableness is allowed for the rotors, and yet, provision of extremely precise bearings are requiered. Further, knives are quite expensive and wear themselves so quickly to shorten service life. Furthermore, highly skilled technique is required to properly replace and adjust knives to the knife rotors, and yet, adjustment could not be done during operation of the synchro-fry cutter.

In order to solve the problems, Applicant provided a push-type rotary cutter (Japanese Patent Laid-open Publication No. 6-304895, 1994) wherein knives provided on the knife rotor cut off a paper or a carboard between the knives and external circumferencial surface of a plane rotor by pushing the knives onto the surface of the plane rotor.

However, in order to replace the conventional synchro-fry cutter with a superior push-type rotary cutter as described above, there occurs economic problems.

Further, it is also required that noises during cutting operation are reduced and that cutting surfaces of paper are beautiful.

The object of the present invention is to provide an improved synchro-fry cutter which could be provided by low cost and which simplifies its maintenance.

SUMMARY OF THE INVENTION

To achieve the above object, the invention according to Claim 1 provides a rotary cutter comprising a knife rotor (1) furnished with at least one knife on external circumferential surface thereof and a plane rotor (2) installed at a position opposite from the knife rotor; characterized in that:

the knives are spirally disposed and;

the knife rotor cuts off a paper or a cardboard between the knives and external circumferential surface of the plane rotor.

The invention according to Claim 2 provides a rotary cutter comprising a knife rotor (1) furnished with at least one knife on external circumferential surface thereof and a plane rotor (2) installed at a position opposite from the knife rotor; characterized in that:

the plane rotor has an elliptic cross section or a polygonal cross section; wherein

the rotary cutter cuts off a paper or a cardboard between lateral-side portion of the plane rotor and knives of the knife rotor.

The invention according to Claim 3 provides a rotary cutter comprising a knife rotor (1) furnished with at least one knife on external circumferential surface thereof and a plane rotor (2) installed at a position opposite from the knife rotor; characterized in that:

a knife-holding means holds each knife to a knife-mounting portion of the external surface of the plane rotor with play.

The invention according to Claim 4 provides a rotary cutter comprising a knife rotor (1) furnished with at least one knife on external circumferential surface thereof, characterized in that:

a swingable thick-plate member (44) is installed at a position where lateral surface of the thick-plate member substantially comes into contact with the knife rotor, wherein the knife rotor cuts off a paper or a cardboard between the lateral surface of the thick-plate member and the knives.

The invention according to Claim 5 provides a rotary cutter comprising a knife rotor (1) furnished with at least one knife on external circumferential surface thereof and a plane rotor (2) installed at a position opposite from the knife rotor; characterized in that:

a circumferential-surface member having paper-cutting surface is formed on circumferential surface of the plane rotor in order that a paper or a cardboard can be cut off between the paper-cutting surface of the circumferential-surface member and the knives.

The invention according to Claim 6 provides a rotary cutter of claim 4, wherein a circumferential-surface member having paper-cutting surface is formed on lateral surface of the thick-plate member in order that a paper or a cardboard can be cut off between the paper-cutting surface of the circumferential-surface member and the knives.

The invention according to Claim 7 provides a rotary cutter of claim 1, 2, 3, 4, 5 or 6, wherein the cross section of the knife rotor is elliptic or polygonal and the knife rotor is equipped with knives on lateral sides which designate the farthest sides from elliptic-cylindrical or polygonal-cylindrical axis.

The invention according to Claim 8 provides a rotary cutter comprising a knife rotor (1) furnished with at least one knife on external circumferential surface thereof and a rotatable plane rotor (2) or a thick-plate member (44) installed at a position opposite from the knife rotor, said rotary cutter further comprises:

a bearing-support mechanism (8a, 9a, 8b, 9b, 26) comprising a toggle joint (26) wherein

an end (8a) of a bearing (8) of the plane rotor or the thick-plate member rotatably supports an end (9a) of a bearing (9) of the knife rotor and

the other end (8b) of the bearing (8) of the plane rotor or the thick-plate member swingably supports the other end (9b) of a bearing (9) of the knife rotor, whereby

the plane rotor or the thick-plate member and knife rotor comes close to or departing from each other;

a bearing pressurizing mechanism (38, 39, 24) energizing the other end (8b) of the bearing (8) of the plane rotor or the thick-plate member and the other end (9b) of a bearing (9) of the knife rotor in the direction of coming close to each other; and

a stopper means (36, 27) for controlling amount of projection of a center portion of the toggle joint.

The invention according to Claim 9 provides a rotary cutter of claim 2, 3, 4, 5 or 7, wherein the knives are spirally disposed.

The term "plane rotor" in the above paragraphs designates a rotor having a circumferencial surface to contact with tips of blades of knives provided on the knife rotor. The cross section of the plane rotor is not limited to a round shape but might be a polygonal shape such as a triangle or a square only if the plane rotor would smoothly rotate about its shaft.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic explanatory view of the rotary cutter according to the first embodiment of the invention;

Fig. 2 is a schematic front view of the rotary cutter according to the first embodiment of the invention;

Fig. 3 is a schematic lateral view of the rotary cutter according to the second embodiment of the invention;

Fig. 4 is a partial sectional view of the knife rotor of the rotary cutter shown in Fig. 2;

Fig. 5 is a schematic explanatory view of the clearance adjusting mechanism of the rotary cutter sown in Fig. 2;

Fig. 6 is a perspective view of the rotary cutter shown in Fig. 2;

Fig. 7 is a plan of the rotary cutter shown in Fig. 5;

Fig. 8 is a schematic explanatory view of the rotary cutter according to the second embodiment of the invention;

Fig. 9 is a partial sectional view of the plane rotor secured with the circumferential surface member;

Fig. 10 is a schematic explanatory view of combination of the knife rotor (of another embodiment) used for the inventive rotary cutter with the plane rotor;

Fig. 11 is a schematic explanatory view of the rotary cutter according to the third embodiment of the invention;

Fig. 12 is a sectional view of the knife rotor and the plane rotor of the rotary cutter according to the fourth embodiment of the invention; and

Fig. 13 is a schematic front view of the rotary cutter according to the fifth embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the accompanying drawings explanatory of embodiments, details of the inventive rotary cutter are described below.

Embodiment 1

Fig. 1 is explanatory of the rotary cutter according to the first embodiment of the invention. Fig. 2 is a schematic front view of the rotary cutter of the first embodiment. Fig. 3 is a schematic lateral view of the rotary cutter shown in Fig. 2. Fig. 4 is a sectional view of fundamental components of the knife rotor of the rotary cutter shown in Fig. 2. Fig. 5 is a schematic explanatory view of the clearance adjusting mechanism of the rotary cutter shown in Fig. 2.

The reference numeral 1 shown in Figures 1, 2, and 3 designates a knife rotor secured with a pair of knives 5a and 5b on two lateral sides of an elliptic-cylindrical body. The reference numeral 2 designates a metallic plane rotor having hard and smooth external circumferential surface. The reference numeral 3 designates a feed roll in close contact with a plane rotor set to a position closest to the knife rotor 1. The reference numeral 4 designates a lengthy cardboard to be cut off. The reference numeral 6 designates a slitter for adjusting width of a paper via cutting. The reference numeral 7 designates a rotary encoder detecting the number of the rotation of the plane rotor for identifying speed of feeding the cardboard 4. The reference numeral 8 designates a plane-rotor bearing secured to a frame A. The reference numeral 9 designates a knife-rotor bearing. The reference numeral 10 designates a pinch roller unit pulling the cardboard 4 at a predetermined speed. The knife rotor 1 requiring precise control of rotational number is driven by a servo motor 13 shown in Fig. 3. On the other hand, since the circumferential rotational speed of the plane rotor 2 may substantially be identical to that of the knife rotor 1 without necessarily synchronizing with each other, precise control of the rotational number is not required, and thus, the plane rotor 2 is driven by a conventional variable-speed AC motor 14 capable of optionally adjusting rotational speed.

It is permissible to use a conventional feed roll in place of the feed roll 3. By effect of replacing such a conventional drum-shaped knife rotor with the knife rotor 1 featuring the above structure, by virtue of setting the knives 5a and 5b to a preset standby position afloat external circumferential surface of the plane rotor 2 before activating operation of the rotary cutter, a cardboard 4 can easily pass between the knife rotor 1 and the plane rotor 2, thus readily setting the cardboard 4. Whenever operating such a conventional rotary cutter by securing a plurality of knives to a single rotor, it was

always difficult to properly adjust interlocking effect between them. On the other hand, since the inventive rotary cutter secures a pair of knives 5a and 5b to a single knife rotor 1 without requiring difficult adjustment work, the knife rotor 1 can cut off a paper or a cardboard by optional length shorter than that was normally achievable by any conventional knife rotor at the identical rotational speed. In addition, the inventive knife rotor 2 is driven by less power of the servo motor, thus making it possible to sharply save power and compactly build the knife rotor 1. Furthermore, since the inventive knife rotor 1 is of elliptic-cylindrical shape, compared to such a conventional circular-cylindrical knife rotor, the inventive knife rotor is lighter in weight and incurs less flywheel effect. Even when repeating quick acceleration and deceleration, the inventive knife rotor 1 crisply rotates itself to enable knives 5a and 5b to cut off the paper at the exact cutting position with less amount of power. As mentioned earlier, since no synchronization is needed between rotations of the plane rotor 2 and the knife rotor 1, such a conventional variable-speed motor being cheaper in cost than a servo motor may be introduced, and yet, since the plane rotor 2 can be driven with a belt via an external drive source, investing cost on the rotary cutter can be reduced.

Referring now to Fig. 1, initially, a cardboard 4 is pulled by a pinch roll unit 10 installed on the upstream side of a feed roll unit 3. Edges of the carboard 4 pulled out of the pinch roll unit 10 are properly cut off by a slitter unit 6, and then the cardboard 4 is conveyed in the direction of the rotation of the plane rotor 2 after being nipped between the plane rotor 2 and the feed roll unit 3. In the meanwhile, while the knife rotor 1 rotates, the feed roll unit 3 is set to a position close to the knife rotor 1 up to such an extent in which the knives 5a and 5b are still out of contact with the feed roll unit 3. Owing to this arrangement, distance between the knife rotor 1 and the feed roll unit 3 becomes shortest. This in turn causes free-run of the conveyed cardboard 4 to become extremely short to stabilize travelling posture of the cardboard 4 pulled out of the feed roll unit 3, thereby achieving high precision in cutting off the cardboard 4, and yet, eliminating the need for providing such a unit for preventing the cardboard 4 from unstably being conveyed. Since the knife rotor 1 and the feed roll unit 3 are conjunctionally installed on the external cicumferential surface of the identical plane rotor 2, provision of another feed roll unit conventionally being set behind a guide plate 11a is no longer necessary, thus simplifying the operating structure to contract space needed for accommodating the whole structutres to save the investment cost.

The number of the rotation of the plane rotor 2 is constantly counted by a rotary encoder 7 set to a plane-rotor bearing 8. Based on data on the number of the rotation of the plane rotor 2, operating speed of the pinch roll unit 10 for feeding a paper or cardboard 4 is properly adjusted. Simultaneously, based on the speed of the rotation of the plane rotor 2, length of the supplied cardboard 4 is computed, and then activating timing of the knife 5a in the state shown in Fig. 1 for cutting off the cardboard 4 is measured. Next, rotation of a servo motor 13 shown in Fig. 3 is controlled to start off rotation of the knife rotor 1 so that the knife 5a can be brought to a predetermined cutting position. In order to prevent the cardboard 4 from being torn off or slacking itelf on the way of cutting operation, moving speed of the knife 5a, in other words, speed of the rotation of the knife rotor 1, is compulsorily set in perfect accord with the speed of feeding the cardboard 4.

In this way, the knife rotor 1 is rotated by operating the servo motor 13 capable of correctly controlling own rotational speed, thereby enabling the knife 5a and the other knife 5b to alternately cut off the cardboard 4. The cut-off cardboard 4 is then led to a guide board 11b and then conveyed forward as of the state being nipped between a conveyer 12a and another conveyer 12b.

It is also permissible to drive the plane rotor 2 via a belt engaged with a conventional motor installed at a remote location. Except for the time of executing cutting operation, the knife rotor 1 may be rotated at any speed. According to the first embodiment, while the cardboard 4 is shifted over the plane rotor 2 up to the cutting position, as shown in Fig. 1, the knife rotor 1 remains in the standby posture by laterally holding the knives 5a and 5b.

In order to detect actual speed of the cardboard 4 being fed, speed of the rotation of the pinch roll unit 10 installed on the up-stream side of the feed roll 3 may be measured by means of a rotary encoder 7a.

Unlike any conventional synchronized fly cutter, the rotary cutter according to the first embodiment of the invention dispenses with such a difficult adjustment work for interlocking knives of the upper and lower rotors, and thus, skilled adjustiment technique is not required for maintenance.

The feed roll 3 shown in Fig. 2 is conventionally known, which is rotatably held by a bearing 3b, wherein the other end of the bearing 3b is rotatably linked with a pneumatic cylinder 3a rotatably held by a plane rotor bearing 8. By effect of pneumatic force from the pneumatic cylinder 3a, the feed roll 3 is pressed against external circumferential surface of the plane rotor 2. Device for supporting the feed roll 3 and fittings for installing the pneumatic cylinder 3a may be provided independent of the frame A. Since the feed roll 3 is rotatable relative to the rotation of the plane rotor 2, external circumferential surface of the feed roll 3 is fully covered with soft material for prevention from slipping.

As components of bearing supporting mechanism shown in Fig. 2 and Fig. 3, an end 8a of the plane rotor bearing 8 rotatably supports an end 9a of a knife rotor bearing 9, whereas the other end 8b supports the other end 9b of the knife rotor bearing 9 via a toggle joint 26.

Supporting bases 38 and 38 are rotatably set to both ends of an extended shaft of a plane rotor shaft 2a, whereas supporting bases 39 and 39 are rotatably set to both ends of an extended shaft of a knife rotor shaft 1a. Pneumatic springs 24 and 24 are secured between the upper supporting bases 39 and 39 and the lower sup-

porting bases 38 and 38. The pneumatic springs 24 and 24 are respectiely energized in the expansive direction. However, since the upper supporting bases 39 and 39 and the lower supporting bases 38 and 38 mutually press against each other as of the above condition to cause them to rotate themselves to incline their posture, linkage plates 40 are provided therebetween to prevent them from rotating and tilting themselves. Upper portions of the linkage plates 40 are secured with bolts, whereas lower portions are slidably held by sliding grooves 40a so that the linkage plates 40 can slide themselves solely in the vertical direction. Owing to this arrangement, the upper supporting bases 39 and 39 and the lower supporting bases 38 and 38 shift themselves in parallel with each other. The upper supporting bases 39, the lower supporting bases 38, and the pneumatic springs 24 conjunctionally correspond to the bearing pressurizing unit.

The bearing pressurizing unit exerts pressure against the knife rotor shaft 1a and the plane rotor shaft 2a in the direction to separate the knife rotor bearing 9 from the plane rotor bearing 8. However, since the knife rotor bearing 9 and the plane rotor bearing 8 are restrained by the bearing supporting mechanism, in consequence, the knife rotor 1 deflects downwards, whereas the plane rotor 2 deflects upwards. When cutting off the cardboard 4 with the knife rotor 1, since the center portion of the knife rotor 1 delects upwards, uncut portion may be generated. However, owing to the downwardly deflective effect, force is exerted against the center portion of the knives 5a and 5b to eliminate uncut portion from the cardboard 4. Since the plane rotor 2 is downwardly deflected by own weight, owing to the upwardly deflective effect, posture of the plane rotor 2 is corrected.

Because of function of the bearing pressurizing unit, bearings accommodated in the upper supporting bases 39 and the lower supporting bases 38, the knife rotor bearing 9, and the plane rotor bearing 8, are respectively pressurized in predetermined directions. This in turn makes it possible to restrain radial-directional clearance of respective bearings and gap of respective supporting points of the bearing supporting mechanism, thereby preventing rotary shafts from wobbling themselves. Because of this, conventional bearings can be introduced instead of high-precision bearings, thus resulting in the substantial advantage not only for the manufacturing convenience, but also for maintenance work.

It is also permissible to make use of oil-pressure cylinders or coil springs in place of the pneumatic springs 24 and directly secure the pneumatic springs 24 between the knife rotor 1 and the plane rotor 2.

By turning a screw 27 incorporating micro-pitches secured to the toggle joint 26, a toggle step 36 shifts to the left and to the right to vary interval between the ends 8b and 9b of the plane rotor bearing 8 and the knife rotor bearing 9.

As shown in Fig. 2, since expansive pressure of the pneumatic spring 24 as component of the bearing pressurizing unit works in the direction of separating the knife rotor shaft 1a from the plane rotor shaft 2a, the toggle step 36 of the toggle joint 26 constantly exerts pressure against the screw 27, thus eliminating the need to link the toggle step 36 with the screw 27. Consequently, gear box 25 can be provided independent of the toggle joint 26.

As shown in Fig. 4 (a sectional diagram), the knives 5a and 5b are respectively secured to knife mounting portions 16a of the knife holders 16 which are respectively coupled with grooves 1a formed in the longitudinal direction of the knife rotor 1, where several portions of each knife holder 16 are secured with bolts. The knife mounting portion 16a designates slender space formed by cutout portion and the groove 1a. A thinly formed lengthy permanent magnet 17 is set to wall surface on the part of the bolt, and then the knife 5a is inserted in space formed between the permanent magnet 17 and the groove 1a. In consequence, since the knife 5a is made of steel, it is absorbed by magnetic force of the permanent magnet 17. In order that the space can reserve play when mounting the knife 5a therein, thickness of the permanent magnet 17 is adjusted to be slightly thicker than the knife 5a. Because of this arrangement, the knife 5a slightly moves itself while the cutting operation is underway.

It is also permissible to form a permanent magnet by means of a magnetic sheet containing flexible elasticity.

It is by no means necessary to introduce specially adjusted expensive knives for the provision of the knives 5a and 5b, but instead, commercially available thin-blade knives may also be used, and thus, wear and tear expenses can be reduced. Commercially available knives are finished with high precision, and thus, these knives can securely be mounted in the knife-mounting portion 16a. In addition, these knives can readily be mounted. For example, even when setting such a knife having about 2 meters of length, setting work can be completed within 20 seconds.

Interspace between the knife 5a for example and wall surface of the groove 1a is emphatically illustrated in Fig. 4. However, in the actual case, there is merely quite narrow clearance between them. The knives 5a and 5b used for the inventive rotary cutter comprise conventionally known thin blades each having a maximum of 5μm of precision in the height of the blade with V-shaped double-edge. Not only the V-shaped double-edged blades, but those knives each consisting of a linear blade, a torsional blade, a single-edged blade, or double-step blades, may also be introduced.

It is of course permissible to directly form the knife-mounting portion 16a for securing the knife 5a thereto in the knife rotor 1 or the knife holder 16. Although the knife holder is formed by way of rectangular prism in this embodiment, it may also be shaped by way of wedge. The permanent magnet 17 corresponds to the knife-holding means cited earlier.

Referring now to Fig. 5, clearance S between the tip of the knife 5a secured to the knife rotor 1 and externmal circumferential surface of the plane rotor 2 is constantly

detected with extremely high precision as per 1μm unit based on those processes including initial emission of light from a photo-oscillator 29 set to the plane rotor bearing 8 followed by reception of width data of light leaked through the tip of the blade of the knife 5a and the plane rotor 2 by a receiver 30 of a photo-sensor. The detected data is computed by a controller unit 31 for storage in memory 32. Simultaneously, computed data of clearance S is digitally shown on a clearance display panel 35b of the operation desk 35.

Desired dimensional numerical value of clearance S is set by the clearance setting unit 35a built in the operation desk 35. On receipt of the desired value of clearance S by the controller unit 31, instruction unit 33 transmits control signal to a motor 28 shown in Fig. 2 (the motor 28 itself makes up part of a clearance adjusting unit 34) to activate driving of a gear box 25, which then moves a micro-pitch screw 27 back and forth. The clearance adjusting unit 34 comprises the toggle joint 26 functioning as the bearing supporting unit, the motor 28, the gear box 25 which is driven by the motor 28 and provided with high speed-reduction ratio, and the micro-pitch screw 27 driven by the gear box 25, in combination with each other. The photo-oscillator 29, the receiver 30, and the controller unit 31 integrally make up a clearance detecting means.

When contracting clearance S, the screw 27 is driven forward to internally push the toggle step 36 to lower the knife rotor bearing 9. This in turn causes the knife rotor 1 to descend itseelf to contract clearance S. When expanding clearance S, the screw 27 is driven backward to enable the toggle step 36 to externally emerge to cause the knife rotor 1 to ascend itself.

By enabling the memory 32 to previously store data of clearance S according to the kind and the number of paper or cardboard prepared for cutting, owing to provision of the clearance adjusting unit 34, even when varying the kind of paper or cardboard, the controller 31 can immediately instruct optimal amount of lowering the knives. In this way, actual clearance can easily be detected by the clearance detecting means. Even when the cutting operation is underway, clearance can optionally be adjusted by controlling operation of the clearance adjusting unit based on the detected data.

Transferrable amount of the screw 27 can correctly be measured by the rotary encoder 37 secured to an end of the screw 27.

Concretely, clearance S can be adjusted very precisely as per 1μm unit in a scope ranging from -0.5mm up to +1.5mm on the basis of S = 0, where S designates position in contact with the plane rotor 2.

Sharpness of knives and rounds of cutting during the cutting operation are encoded by the controller 31 of the clearance detecting unit for storing these data in the memory 32, thereby making it possible to identify correct time of replacing the knives.

Since the knife rotor 1 is disposed relative to the position of the plane rotor 2, these rotors may be disposed inversely in the vertical arrangement or these may be installed by way of horizontal arrangement.

Embodiment 2

Fig. 6 is a perspective view of the knife rotor and the plane rotor of the rotary cutter according to the second embodiment of the invention. Fig. 7 is a plan of the knife rotor and the plane rotor shown in Fig. 6. Fig. 8 is a schematic illustrative view of the rotary cutter shown in Fig. 6. Fig. 9 is an enlarged sectional view of the cutting mechanism of the rotary cutter shown in Fig. 8.

The reference numeral 20 shown in Figures 6 through 8 designates the knife rotor to which a pair of knives 20a and 20b are spirally secured. The reference numeral 21 designates the plane rotor to which circumferential surface members 21a and 21b are spirally secured. The knives 20a and 20b respectively consist of a commercially available lengthy thin-edged knife, which are respectively secured to knife-mounting portion of a knife holder. The circumferential surface members 21a and 21b each consisting of a prismatic metallic member having cutting surface 21c or 21d in opposition from the knives 20a or 20b. The circumferential surface members 21a and 21b are respectively secured to positions at which the knives 20a and 20b are brought into contact with the corresponding cutting surfaces 21c and 21d while the rotary cutter rotates. The reference numeral 15 designates a rolled paper to be cut off by a predetermined length.

As shown in Fig. 6, the knife rotor 20 and the plane rotor 21 respectively rotate themselves in the arrowed direction. When observing this condition by way of planar view, as shown in Fig. 7, the knife rotor 20 and the plane rotor 21 are respectively installed without being orthogonal to the direction of feeding the rolled paper 15, but these are obliquely set in correspondence with setting angles of the spirally installed knives 20a and 20b and circumferential surface members 21a and 21b in order that the rolled paper 15 can be cut off by way of being orthogonal to the paper-feeding direction. In order to correctly set the cutting angle at right angle, fine adjustment is performed by relatively varying the speed of feeding the rolled paper 15 and the speed of the rotation of the knife rotor 20 and the plane rotor 21. As the rolled paper 15 in the state shown in Fig. 7 is shifted in the arrowed direction, the paper 15 is pressed against the cutting surface 21c by the knife 20a at a point at which tip of the blade of the knife 20a comes into contact with the cutting surface 21c, in other words, at a point on a line interlinking rotary axes 20e and 21e of the two rotors 20 and 21, before being cut off. Since the knife 20a and the circumferential surface member 21a are spirally secured, relative to the rotation of the knife rotor 20 and the plane rotor 21, the paper 15 is gradually cut off from the left end at which the knife 20a and the circumferential surface member 21 come into contact with each other up to the right end thereof. Because of this arrangement, only a slight amount of pressing force is exerted, and yet, the both

rotors can be driven with insubstantial amount of power. Furthermore, since the paper 15 is gradually cut off, cutting noise is minimized. The knives 20a and 20b continuously cut off the rolled paper 15 by a predetermined length while repeatedly executing the above operations in association with the circumferential surface members 21a and 21b. The paper feeding speed and the shifting speed of the knives 20a/20b and the circumferential surface members 21a/21b are adjusted to be equal to each other.

While the paper cutting operation is executed with the rotary cutter having knives 20a/20b spirally being secured to the knife rotor 20 according to the second embodiment of the invention, the cutting surface 2c with which the rolled paper 15 is brought into contact is formed on circumferential surface having radius comprising a distance b between the rotary axis 21e of the plane rotor 21 and bottom surface of the rolled paper 15, where the distance b corresponds to the result of a subtraction of distance a between the rotary axis 20e and the tip of the blade of the knidfe 20a from distance c between the rotary axes 20e and 21e. Width of the cutting surfaces 21c and 21d is arranged within working angles of the knives 20a and 20b while executing acceleration, cutting operation, and deceleration. Minimum width of the cutting surfaces 21c and 21d is arranged to be ±20mm from the paper cutting position.

Next, referring to Fig. 9, further details of the cutting condition are described below. In Fig. 9, the knife 20a is pressed onto an opposite wall surface by a rubber-made O-ring 19 set to wall surface on the part of a bolt of the knife mounting portion 18a of the knife holder 18. The circumferential surface member 21a is secured to a groove 22 formed in the longitudinal direction of the plane rotor 21 with a lengthy pressing member 23 made from hard plastics. Since the groove 22 has tapered section, while fastening bolts in several spots for securing the pressing member 23, the circumferential surface member 21a is pressed against the opposite wall surface before firmly being secured to the groove 22. Clearance between the tip of the blade of the knife 20a and the cutting surface 21c is finely adjusted by the clearance adjusting unit described earlier.

The rolled paper 15 conveyed from the left moves itself at a speed identical to the moving speed of the knife 20a and the circumferential surface member 21a before being cut off. Even though the shifting movement of the knife 20a and the circumferential surface member 21a slightly differs, since the knife 20a slightly moves itself relative to the movement of the circumferential surface member 21a by effect of the play of the knife mounting portion, the rolled paper 15 remains free from being torn off.

Furthermore, owing to the provision of the circumferential surface members 21a and 21b, even when the cutting surface 21c incurs ruggedness as a result of pressure from the knives 20a/20b or prolonged service, the rotary cutter can constantly maintain sharp cutting effect merely by replacing the cicumferential surface members 21a and 21b. Material of the circumferential surface members is not solely limited to metal, but hard plastics may also be used.

As exemplified in the second embodiment, shape of the plane rotor is not solely limited to drum-shape. Furthermore, a variety of shapes can be applied to the knife rotor and the plane rotor. Fig. 10 (A) through (C) exemplify sectional views of varied shapes of the knife rotor. The knife rotor 41 shown in Fig. 10 (A) has regular triangle section, where the three sides are respectively provided with a piece of knife. The plane rotor 42 corresponding to the knife rotor 41 also has regular triangle section having circumferential surface members being secured to three sides thereof. The knife rotor and the corresponding circumferential surface member shown in Fig. 10 (B) respectively have square section. The knife rotor and the circumferential surface member shown in Fig. 10 (C) respectively have regular pentagonal section. A plurality of knives are secured to the longitudinal-direction portions (lateral sides) corresponding to sectional summit positions of the knife rotor. Sectional forms are predetermined in order that the axes will compulsorily pass through the center of gravity. When the knives are spirally secured to the knife rotor, except for the drum-shaped plane rotor, all the knives should necessarily be secured so that the cutting surface can be brought into contact with the tip of the blades of knives in the course of rotating the knife rotor and then the knife rotor be rotated.

Embodiment 3

Fig. 11 is a schematic explanatory view of the rotary cutter according to the third embodiment of the invention. The knife rotor 43 provided with a pair of knives 43a and 43b is rotated in the arrowed direction. In place of a plane rotor, a metallic thick plate member 44 having the illustrated section is provided in order that it can stably swing itself around a swinging shaft 44b. Although the upper and lower portions of thick-plate member 44 are not symmetrically formed, the center of gravity is above the swinging shaft 44b. A circumferential surface member 44c is inserted in lateral surface 44a being opposite from the knife rotor 43 at a position with which the knives 43a and 43b respectively come into contact. The reference numeral 45 designates a rolled paper to be cut off.

The thick-plate member 44 swings itself in correspondence with the movement of the tips of the blades of the knives 43a and 43b and then enables the knife 43a to cut off the paper 45. Fig. 11 illustrates the state immediately after cutting off the paper 45. After cutting off the paper 45, the knife rotor 43 rotates in the arrowed direction. On the other hand, the thick-plate member 44 shifts to the left during a period before the other knife 43b downwardly being rotated arrives at the paper cutting position. The thick-plate member 44 then returns to the original position before execution of the cutting operation, and then activates the ensuing cutting work upon arrival of the knife 43b at the cutting position. Speed of

feeding the paper 45 is controlled by a feed roll unit (not shown) before determining the cutting position. The rotary cutter according to the third embodiment repeats the above sequential processes.

It is permissible to spirally secure the knives 43a and 43b to the knife rotor 43. In this case, it is essential that thickness of the thick-plate member 44 be increased, width of the circumferential surface member 44c be expanded or the member 44 itself be secured spirally. To implement swing movement of the thick-plate member 44, either a cam unit, a link unit, or an eccentric crank mechanism, is applicable.

Embodiment 4

The rotary cutter according to the invention may also be embodied by remodelling such a conventional synchronized fly cutter. Fig. 12 is a sectional diagram of the rotary cutter according to the fourth embodiment of the invention.

The rotary cutter shown in Fig. 12 comprises a knife holder 51a for securing a double-edged knife 53 thereto and a circumferential-surface member holder for securing a circumferential-surface member 54 thereto after disengaging knives from knife-securing grooves of the top rotor and the bottom rotor of a conventional synchronized fly cutter.

The knife holder 51a is secured to a groove 51b of a knife rotor (thus far being called a top-rotor) with screws. A commercially available lengthy dual thin-edged knife 53 is secured to the knife holder 51a. A pressing member 52a is secured to a groove 52b of a plane rotor (thus far being called a bottom-rotor) with screws in conjunction with a circumferential surface member 54. The knife rotor 51 and the plane rotor 52 are conjunctionally rotated to cut off a rolled paper 55 by cooperating the dual-edged knife 53 and the circumferential-surface member 54 secured thereto.

When replacing knives, it is permissible to reserve the knife of the synchronized cutter as it was without touching the knife rotor 51 and solely replace the knife of the plane rotor 52 with the circumferential surface member 54.

Since the conventional synchronized fly cutter is correctly synchronized, the knife rotor 51 and the plane rotor 52 can correctly cut off the rolled paper 55 by a predetrmined length. As described above, merely by replacing at least either of the knives with the circumferential member, it is possible to easily remodel such a conventional synchronized fly cutter into an inventive push-type rotary cutter.

Embodiment 5

Fig. 13 is a schematic front view of the rotary cutter according to the fifth embodiment of the invention. Only the different points between the rotary cutter shown in Fig. 1 and the one shown in Fig. 13 are described below.

The reference numeral 62 shown in Fig. 13 dessignates an oil-pressure cylinder whose both ends are secured to a supporting base 58 and another supporting base 59. The oil pressure cylinder 62 exerts energizing force in the direction of constantly bringing both bases to be close to each other. Tensile strength of the oil pressure cylinder 62 can be adjusted by way of feeding and discharging oil. A screw 56 is movable back and forth by a gear box 57 in order to restrain a toggle step 61 from shifting itself to the right.

The oil pressure cylinder corresponds to the energizing means.

Since the oil pressure cylinder 62 constantly energizes a plane rotor bearing 63 and a knife rotor bearing 64 in the direction to be close to each other, a toggle joint 60 is compressed, and thus, a toggle step 61 is constantly apt to project itself to the right. Availing of the force thus generated, a micro-pitch screw 56 is rotated to push the toggle step 61 to the left to stretch the toggle joint 60, thus expanding clearance between the plane rotor bearing 63 and the knife rotor bearing 64.

In place of the oil pressure cylinder 62, it is permissible to use a pneumatic cylinder or a pneumatic spring or a coil spring.

Not only defining to set the oil pressure cylinder 62 between the support base 58 and the other support base 59, but it is permissible to secure an end of the oil pressure cylinder to a frame 65 to lower the set position of the support base 59 or install the oil pressure cylinder 62 between the knife rotor bearing 64 and the plane rotor bearing 63.

According to the rotary cutter of the fifth embodiment, since the oil presssure cylinder 62 energizes the plane rotor or the thick-plate member in the direction of being closer to the knife rotor, optimal pressing force can be set by adjusting oil pressure, in other words, by adjusting energizing force according to the kind of paper. Furthrmore, it also results in the intensified force to properly cut off paper. In addition, since the gear box 57 is provided, both the toggle joint 60 and the screw 56 can correctly set clearance between the tips of the blades of the knives and the circumferential-surface member while the paper cutting operation is underway.

Claims

1. A rotary cutter comprising a knife rotor (1) furnished with at least one knife on external circumferential surface thereof and a plane rotor (2) installed at a position opposite from the knife rotor; characterized in that:

   the knives are spirally disposed and;

   the knife rotor cuts off a paper or a cardboard between the knives and external circumferential surface of the plane rotor.

2. A rotary cutter comprising a knife rotor (1) furnished with at least one knife on external circumferential surface thereof and a plane rotor (2) installed at a

position opposite from the knife rotor; characterized in that:

the plane rotor has an elliptic cross section or a polygonal cross section; wherein

the rotary cutter cuts off a paper or a cardboard between lateral-side portion of the plane rotor and knives of the knife rotor.

3. A rotary cutter comprising a knife rotor (1) furnished with at least one knife on external circumferential surface thereof and a plane rotor (2) installed at a position opposite from the knife rotor; characterized in that:

a knife-holding means holds each knife to a knife-mounting portion of the external surface of the plane rotor with play.

4. A rotary cutter comprising a knife rotor (1) furnished with at least one knife on external circumferential surface thereof, characterized in that:

a swingable thick-plate member (44) is installed at a position where lateral surface of the thick-plate member substantially comes into contact with the knife rotor, wherein the knife rotor cuts off a paper or a cardboard between the lateral surface of the thick-plate member and the knives.

5. A rotary cutter comprising a knife rotor (1) furnished with at least one knife on external circumferential surface thereof and a plane rotor (2) installed at a position opposite from the knife rotor; characterized in that:

a circumferential-surface member having paper-cutting surface is formed on circumferential surface of the plane rotor in order that a paper or a cardboard can be cut off between the paper-cutting surface of the circumferential-surface member and the knives.

6. A rotary cutter of claim 4, wherein a circumferential-surface member having paper-cutting surface is formed on lateral surface of the thick-plate member in order that a paper or a cardboard can be cut off between the paper-cutting surface of the circumferential-surface member and the knives.

7. A rotary cutter of claim 1, 2, 3, 4, 5 or 6, wherein the cross section of the knife rotor is elliptic or polygonal and the knife rotor is equipped with knives on lateral sides which designate the farthest sides from elliptic-cylindrical or polygonal-cylindrical axis.

8. A rotary cutter comprising a knife rotor (1) furnished with at least one knife on external circumferential surface thereof and a rotatable plane rotor (2) or a thick-plate member (44) installed at a position opposite from the knife rotor, said rotary cutter further comprises:

a bearing-support mechanism (8a, 9a, 8b, 9b, 26) comprising a toggle joint (26) wherein

an end (8a) of a bearing (8) of the plane rotor or the thick-plate member rotatably supports an end (9a) of a bearing (9) of the knife rotor and

the other end (8b) of the bearing (8) of the plane rotor or the thick-plate member swingably supports the other end (9b) of a bearing (9) of the knife rotor, whereby

the plane rotor or the thick-plate member and knife rotor comes close to or departing from each other;

a bearing pressurizing mechanism (38, 39, 24) energizing the other end (8b) of the bearing (8) of the plane rotor or the thick-plate member and the other end (9b) of a bearing (9) of the knife rotor in the direction of coming close to each other; and

a stopper means (36, 27) for controlling amount of projection of a center portion of the toggle joint.

9. A rotary cutter of claim 2, 3, 4, 5 or 7, wherein the knives are spirally disposed.

Fig.1

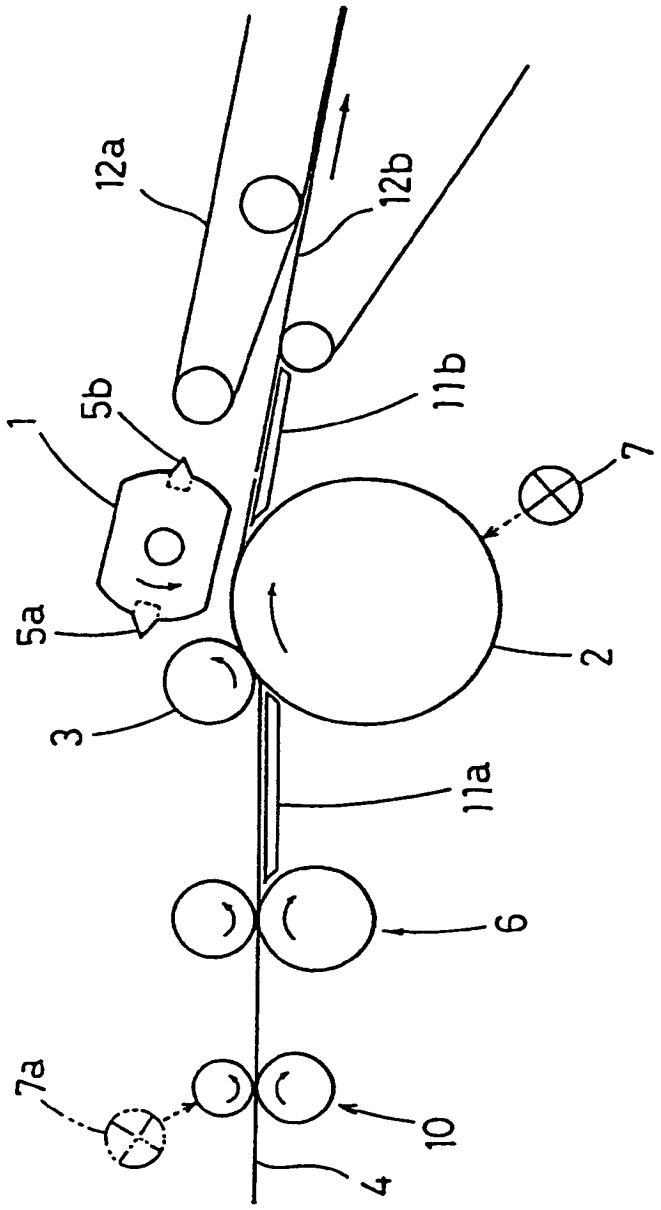


Fig.2

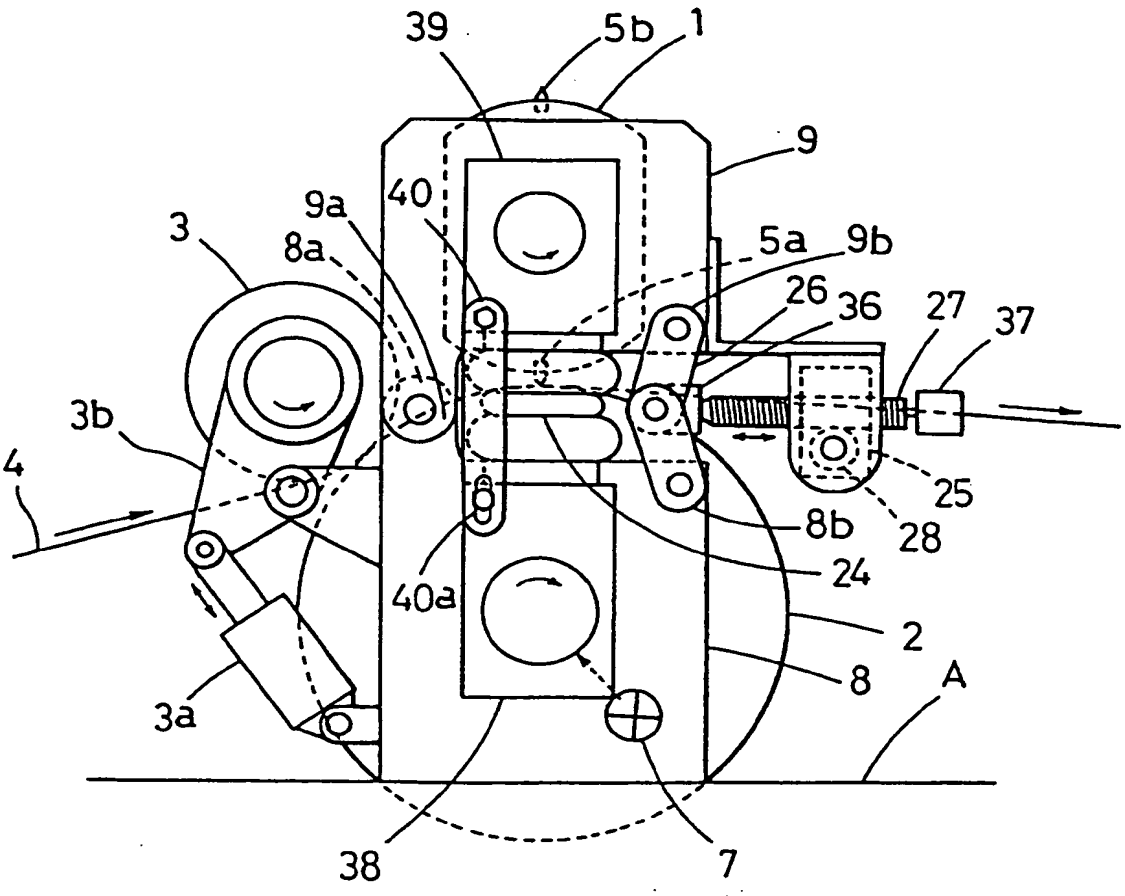


Fig. 3

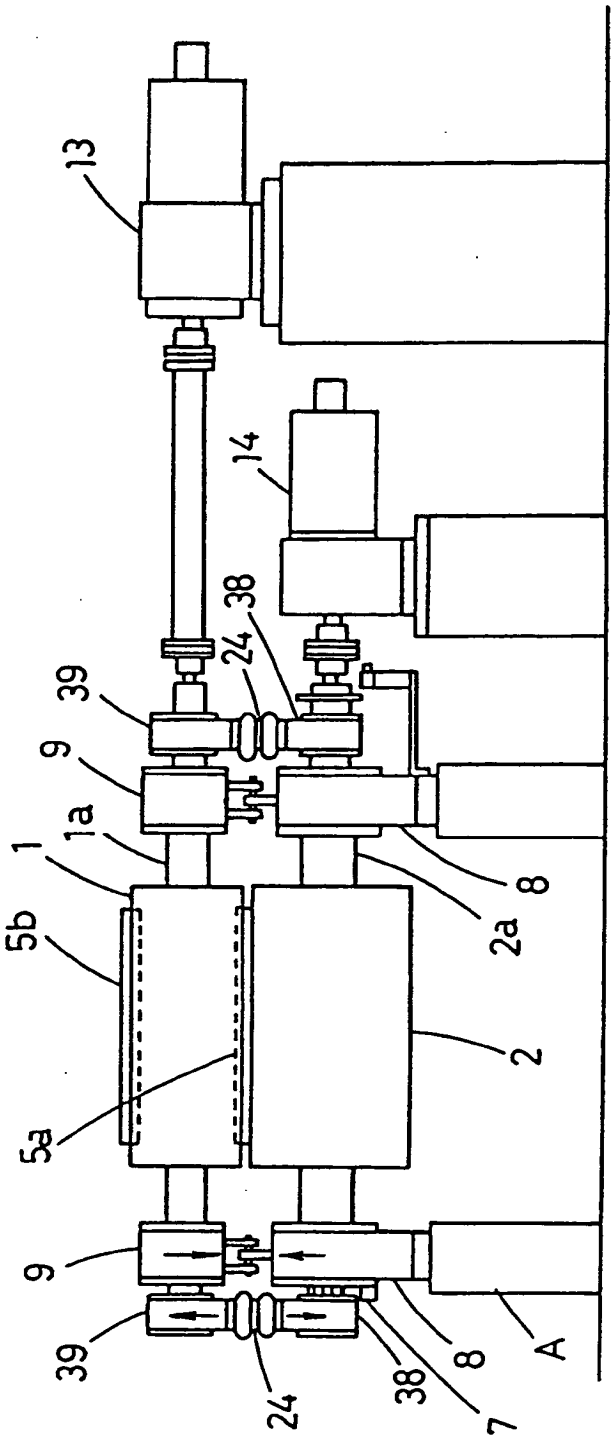


Fig. 4

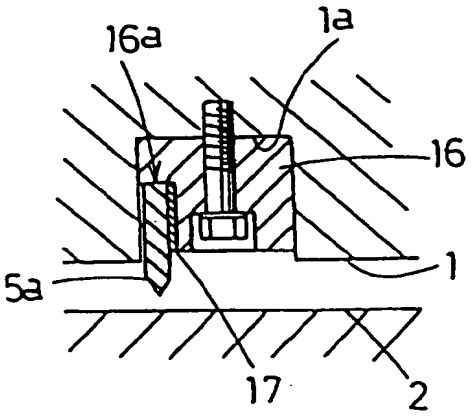


Fig. 5

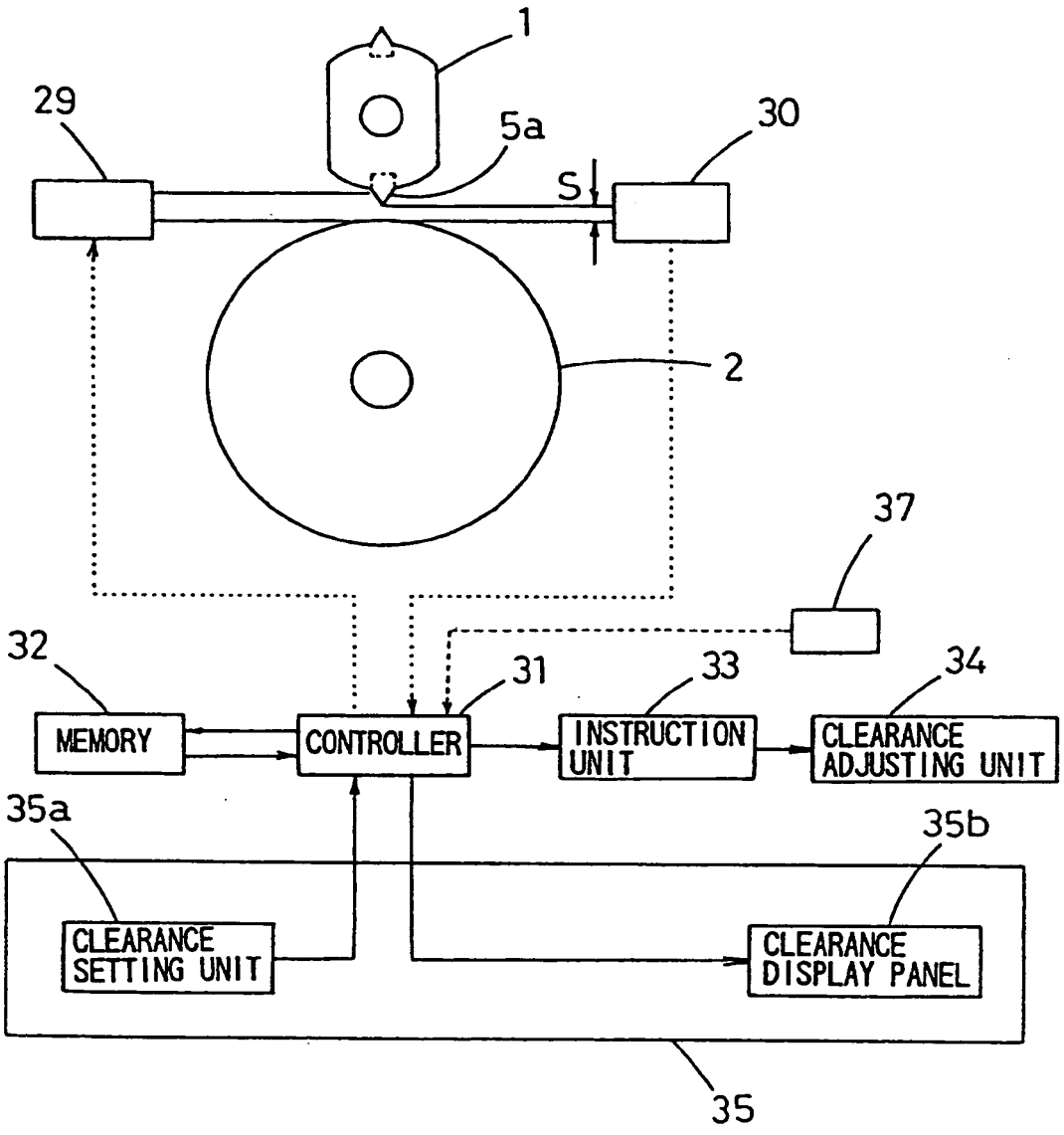


Fig. 6

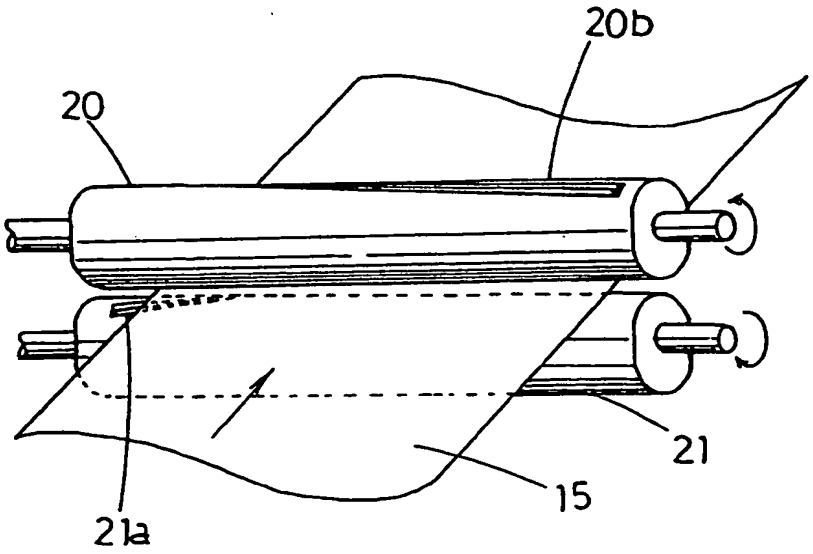


Fig. 7

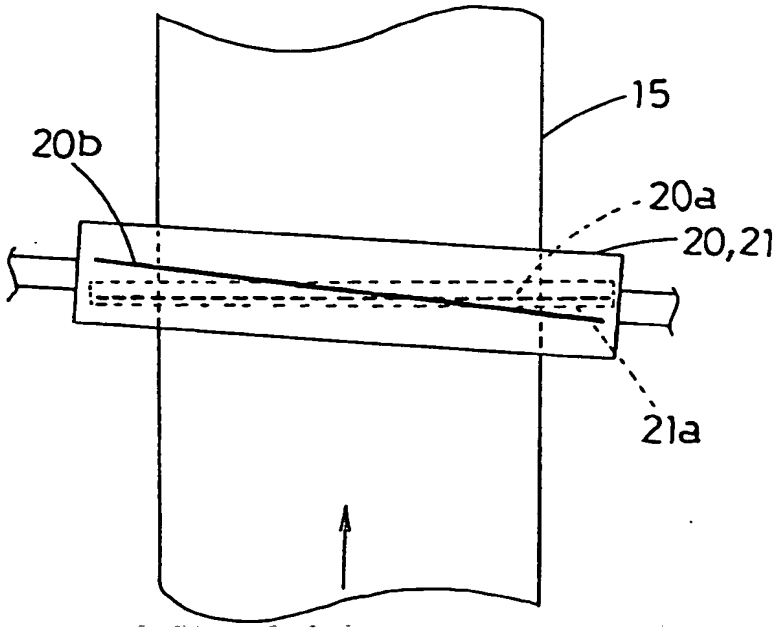


Fig. 8

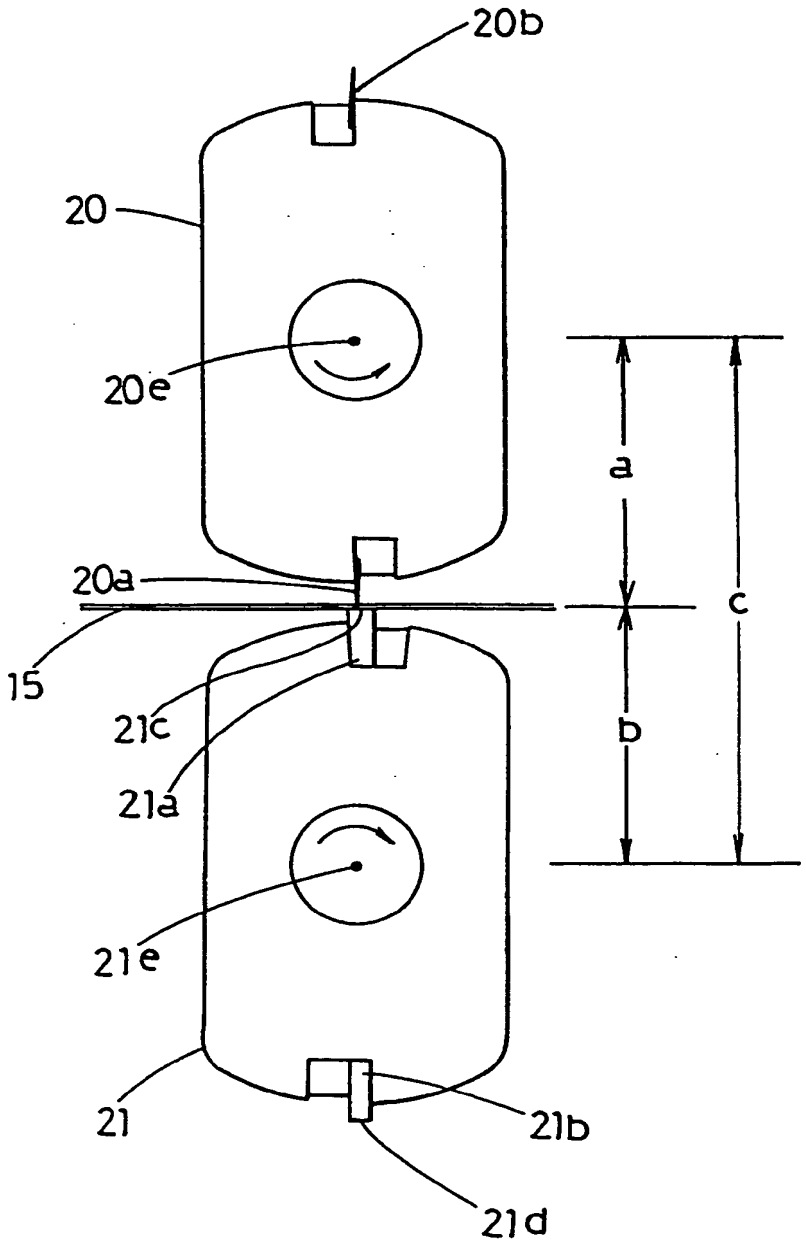


Fig.9

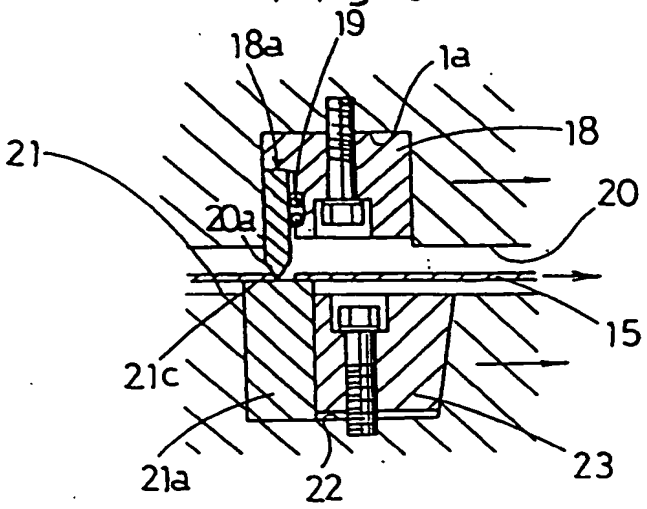


Fig.10

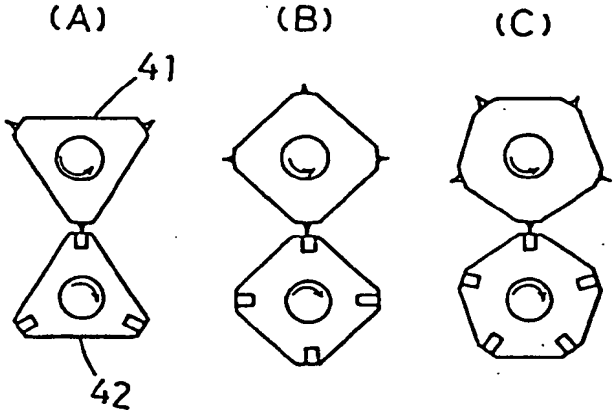


Fig.11

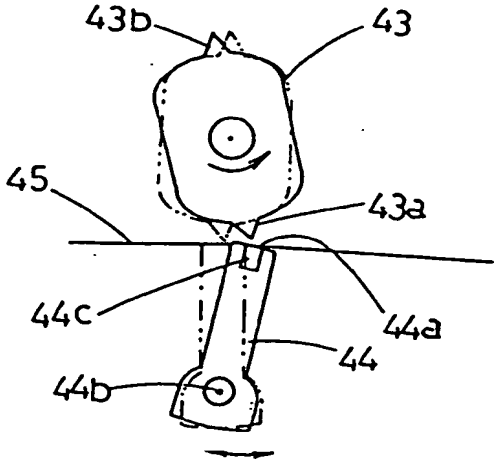


Fig. 12

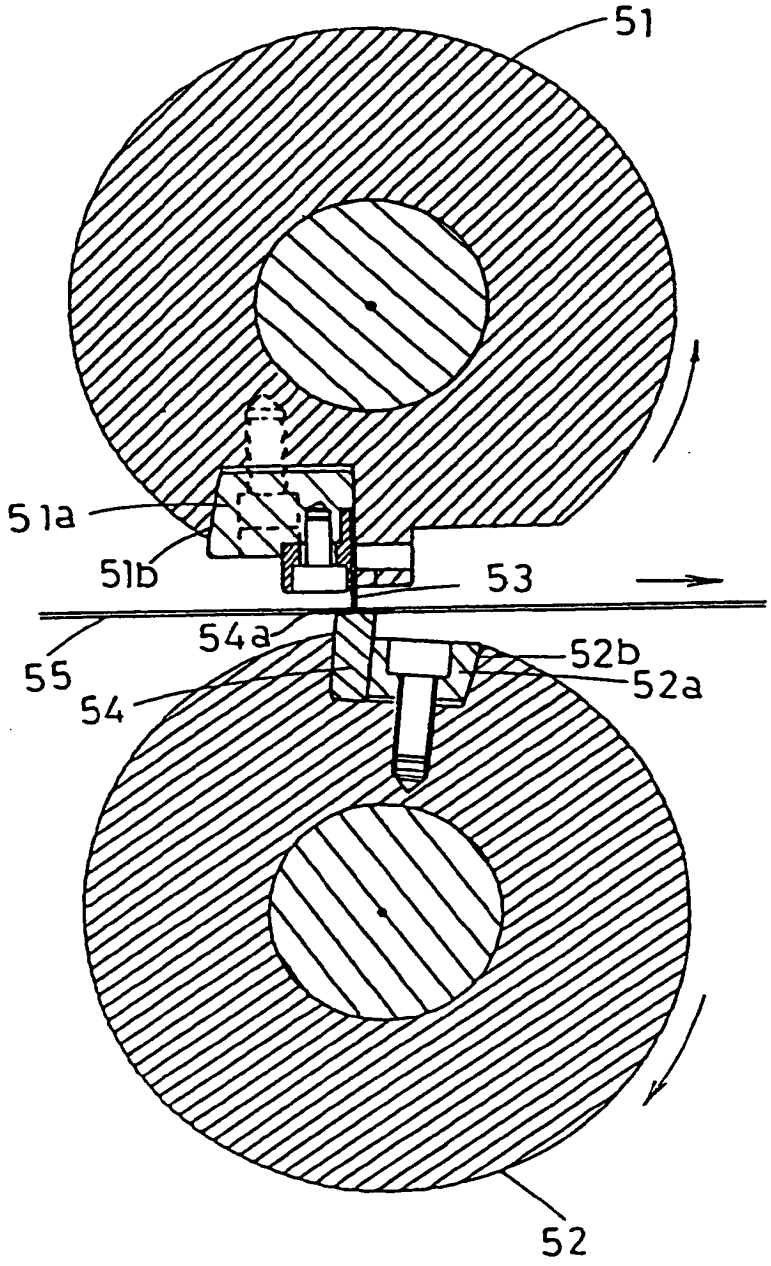
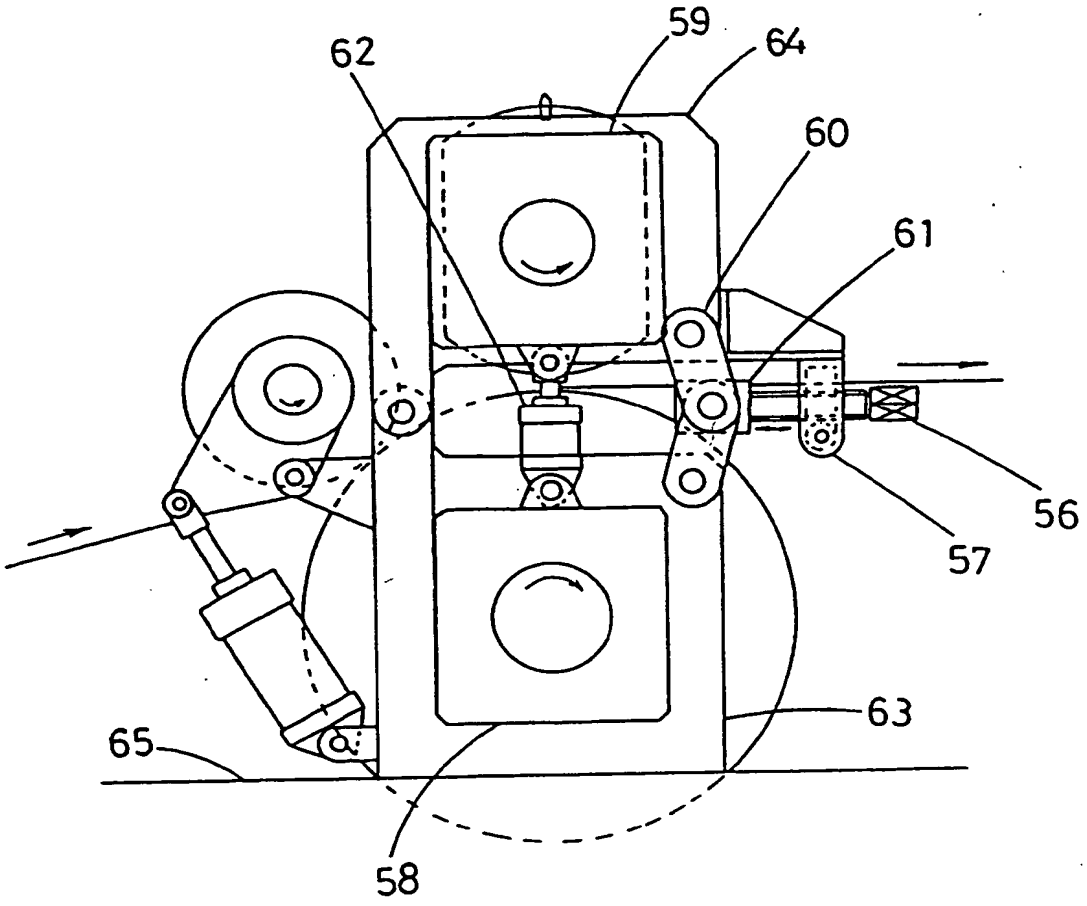


Fig.13



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 30 5002

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	WO-A-87 04658 (LENZI) * page 1, line 1 - page 2, line 30; figures 1-3 *	1	B26D1/62 B26D7/26
X	US-A-4 016 320 (HARRIS) * column 1, line 64 - column 2, line 19; figures 1,2 *	1,5,9	
A	US-A-4 244 158 (NELHAM) * figures 4,5 *	2,7	
X	US-A-3 828 637 (SLACK) * column 1, line 1 - line 40; figures 1,2 *	3	
X	EP-A-0 016 615 (MOLINS) * page 9, line 3 - line 22 * * page 10, line 17 - line 23 * * page 11, line 10 - line 16; figures 2-5 *	3,5	
A		8	TECHNICAL FIELDS SEARCHED (Int.Cl.6)
X	GB-A-681 660 (SHELIMAR PRODUCTS) * page 2, line 3 - line 61; figures 1-4 *	4,6	B26D
A		2,7	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	29 January 1996	Matzdorf, U

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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